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GRINDING DEVICE WITH NOTCHED GRINDING WHEEL ALLOWING THE  
OBSERVATION OF WORK THAT HAS BEEN CARRIED OUT

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The methods and devices for grinding which are known to date do not allow monitoring the surface being ground while the operation is carried out. Therefore, the piece to be ground must be removed from the grinding wheel from time to time for cooling or to check it, resulting in repeated attacks of the machine on the surfaces, so that the precision and finishing of these surfaces are insufficient.

The present invention relates to a grinding device comprising a grinding wheel which rotates at high speed and whose working surface presents notches by means of which it is possible to overcome these drawbacks. The dimensions and the arrangement of these notches provided in the grinding wheel in the shape of slits, holes, etc. are indeed such that, while working, the worker can see, opposite his/her eyes and through notches cut into the grinding wheel, the piece which is brought into contact with the face of the grinding wheel, that is to say, in contact with the attack face of the grinding wheel. It is known that when an object is placed behind a disk into which notches are cut, and the disk is rotated, it becomes perfectly visible starting at a certain speed of rotation. With the aid of the device which is the object of the present invention, it is thus possible to monitor the ground surface during the operation, notably to determine, for example, the precise moment where the grinding must be stopped, or to determine

the exact angle at which the grinding must be carried out. In addition, it is also possible to replace the piece into its initial position with respect to the grinding wheel after it has been removed from the wheel (for example, to cool it). Grinding wheels in fact exist whose working surface have notches, but these notches are either too narrow or too wide, so that the stroboscopic effect does not occur. Moreover, these notches that are cut into the periphery of the grinding wheel do not have the same purpose.

The present invention provides another improvement of said known grinding devices. According to this improvement, one slants the lateral surfaces of at least a part of the notches, if they are in the shape of slits, or the axis of at least part of these notches, if they are in the shape of holes, with a respect to the surfaces of grinding wheels which are in the shape of a disk, or the generating line of grinding wheels that are in the shape of a cup. The flanks of the slits, or the axes of the holes, are thus no longer directed perpendicularly to the peripheral surface or the working surface of the grinding wheel in question, but rather are inclined. The grinding wheel thus acts, in a manner of speaking, like a helix, and it generates a strong air current or turbulence and automatically ensures cooling, so that in many cases it is possible to do without a special device for cooling with water.

According to another characteristic of the invention, it is also possible to obtain or to reinforce this effect by arranging, on the face of the grinding wheel oriented toward the worker, a disk which rotates with the grinding wheel, which has slits in the same arrangement, and whose connector bars which separate slits are curved in the shape of helicoidal blades. When the disk rotates, it acts as a helix and it causes a more intense current of air through the slits or the holes of the grinding wheel, wherein this current of air moves in an effective manner from the worker toward the piece, thus preventing any deterioration of the edges by burning (or heating), without there being any need to provide another cooling means. Naturally, in both cases the dimensions of the slits or holes, or the inclination of the lateral walls of the slits (or of the axes of the holes) must be such that it is still possible to see through them

According to the present invention, these notches can also be provided in an arrangement of rows of holes arranged in a spiral pattern starting at the center of the grinding wheel, where the axis of each hole is located on the cylinder which is concentric with respect to the grinding wheel and tangential to the adjacent holes, where preferably the grinding wheel is embedded in a support perforated in an identical manner. In this manner, one achieves the result that the grinding wheel is uniformly "transparent" at all of its points and an overlapping which may occur with the radial slits at too slow a speed of rotation is absolutely prevented. However, given that these rows of holes notably decrease the rigidity of the grinding wheel, the wheel must be maintained in a support which is capable of preventing its breakdown due to the effects of the centrifugal force.

According to a particular embodiment of the grinding device which is the object of the invention, the piece can be illuminated by a light beam directed through the notches of the grinding wheel toward the surface of the piece being ground, and reflected by the surface toward the worker's eye. The place where material is removed then appears clearly in the shape of a streak and it is markedly set off from places which have not yet been touched by the grinding wheel. The slightest alteration in the grinding angle which must be respected is immediately detected by the placement of the shiny streak, and it can immediately be corrected. Also, it is possible by modifying the grinding angle to bring the place where abrasion is being carried out to the desired point, which has become detectable thanks to the light beam.

According to another characteristic of the invention, for the purpose of making only the illuminated grinding surface visible, in a marked manner, through the notches, and to avoid causing discomfort or blinding of the worker due to the light rays that can be reflected by the face of the grinding wheel, at least the part of the body of the grinding wheel which extends between the notches is tinted with a matte black on the face oriented toward the worker. This blackening clearly must penetrate sufficiently deeply so that the grinding wheel does not become light [colored] when it starts to wear (when it is used turned-over).

A preferred embodiment of the illumination device, which also makes it possible to prevent blinding, consists in providing a light source at a short distance from face of the grinding wheel, close to its shaft, and in masking this light source toward the exterior by means of a screen extending to the immediate vicinity of the face of the grinding wheel, in the area of the slits. It is then advantageous to give this screen the shape of a frustrum-truncated cone which surrounds the shaft of the grinding wheel and to accommodate the edge which forms the base of the cone in a recess in the face of the grinding wheel or behind the curved edge of a disk which is placed next to the grinding wheel, and which is fitted with identical slits and turns with the grinding wheel.

By means of this engagement of the edge of the screen in the recess of the grinding wheel, or behind the curved edge of the supplementary disk, one eliminates the otherwise unavoidable gap between the edge of the screen and the face of the grinding wheel, which would be sufficient to allow light to pass in the direction toward the face of the grinding wheel.

According to yet another embodiment of the object of the invention, the extremities of the notches that are in the form of slits in the grinding wheel obliquely intersect the axis of the grinding wheel, that is to say they describe a cone about the axis of the grinding wheel as they rotate. In the described illumination procedure, the light rays must naturally be oblique with respect to the face of the grinding wheel, they must originate from the axis of the grinding wheel, and they must be directed along the axis of the slit (if the ray contacts the grinding wheel perpendicularly or nearly perpendicularly, it would not produce any useable reflection). Thus,

the terminal surfaces of the slits are inclined (this can be achieved without difficulty given that the deepest part of the slit would remain unilluminated in any case if the terminal surfaces were oriented perpendicularly to the face of the grinding wheel, and this area of the grinding wheel would not contribute to the desired results), and the inclination reduces the dimensions of the notches, increases the rigidity of the grinding wheel, and decreases the risk of the grinding wheel starting to vibrate in a disadvantageous manner.

Finally, the grinding wheel is mounted so that it can pivot about a horizontal axis which is parallel to its faces, and so it can be immobilized. It is also possible to use the grinding wheel either in a horizontal position (for example, for dressing the lower face of the grinding wheel while monitoring the operation from above) as well as in the usual vertical position (for example to grind with the periphery of the grinding wheel while monitoring the operation obliquely and from the side). It is then advantageous that the grinding wheel be able to pivot or be tilted vertically about its lower horizontal tangent, because one can then grind in the two positions without modifying the height of the grinding wheel, so that it is not necessary to modify the height of the point of pressure application of the hand, or the mount which guides the piece. In a particularly simple and efficient manner one can obtain a grinding device which is based on the described principle, but which provides an electric motor that can pivot and that can be immobilized about a horizontal axis cutting its shaft through the middle, and by mounting a grinding wheel cantilevered on each side over the extensions of this shaft.

The drawing in the appendix, which is given as a non-limiting example, shows a satisfactory embodiment of the object of the invention.

Figure 1 is a top view of a flat grinding wheel fitted with simple radial slits;

Figure 2 shows an oblique view of a flat grinding wheel provided with oblique slits;

Figure 3 is a cross section through line III-III of Figure 2;

Figure 4 is a cross section through line IV-IV of Figure 2;

Figure 5 is a partial cross section of a grinding wheel in the shape of a cup (as a dome);

Figure 6 shows a grinding wheel with a supplementary disk which forms helicoidal blades;

Figures 7 and 8 are a top view and a transverse cross section, respectively, of a grinding wheel comprising rows of holes arranged in spiral patterns;

Figures 9 and 10 are a front view and a side view, respectively, of a grinding device;

Figures 11 and 12 are a cross sectional and a top view, respectively, of an illumination device;

Figure 13 shows another embodiment of the illumination device, also in cross section.

The flat grinding wheel 1 shown in Figure 1 has radial slits 2 which, when the grinding wheel turns, allow the worker to observe the piece located behind the grinding wheel. To obtain

a regular view "by transparency," the slits 2 have different lengths so that one has on the periphery of each concentric circle approximately the same proportion of notched surface and working surface. As one can see in Figures 2 and 4, the lateral walls of the notches 2 of the flat grinding wheel 1, which are in the shape of slits, can be inclined with respect to the faces of the grinding wheel. Similarly, it is possible for the terminal faces 3 of the notches 2 that are slit-shaped, to be oriented obliquely, that is they obliquely cut the axis of the grinding wheel, or they describe, as they turn, a cone about the axis of the grinding wheel. As shown in Figure 5, the lateral walls of the slits 2a of the grinding wheel which are in the shape of a cup are also oriented obliquely with respect to the generating line of the grinding wheel.

The disk 4, shown in Figure 6, is arranged against the face of the grinding wheel 1 and turns with it. This disk is also notched, and the connector bars extending between the notches are curved in the shape of helicoidal blades which, during rotation, generate a powerful air current through the slits of the grinding wheel and render any supplementary cooling during grinding superfluous.

The flat grinding wheel 1b, shown in Figures 7 and 8, has three rows of holes 5 arranged in a spiral pattern. The axis of each hole is located on the cylinder which is concentric with respect to the grinding wheel and tangential to the two adjacent holes. The grinding wheel 1b itself is inserted in a support 6 having similar holes.

As shown in Figures 9 and 10, a possible embodiment of the grinding device according to the invention comprises an electric motor 7, supported by axle 9 mounted so it can pivot on a chassis 8, and capable of being immobilized in the chosen position. Two flat grinding wheels 1 are mounted cantilever on shaft 10 that extends on each side of the electric motor. In Figure 10, the position of the grinding wheels and of the motor for the dressing operation is indicated with broken lines, as is the most efficient illumination procedure for this operation.

As one can see in Figures 11 and 12, a luminous body 11 in the shape of a tube, masked toward the exterior by a screen 12, is provided at a short distance from the face of the grinding wheel 1 and in proximity to the shaft 10 of the grinding wheel. This screen 12 constitutes a part of a cone surrounding the shaft of the grinding wheel, and the edge 13 forming the base of this cone engages in a recess 14 of the face of the grinding wheel. In Figure 11, one clearly sees that with the aid of this particular protection procedure light can no longer reach the external edge of the grinding wheel, and the luminous rays are reflected only by the ground surface of the piece 15, in the direction toward the worker's eyes. Instead of the recess 14 provided in the face of the grinding wheel, one can also provide a disk 16 applied against the face of the grinding wheel that is notched similarly and turns with it, and whose edge 17 is bent back. The edge 13 which forms the base of this screen 12 also engages behind the bent edge 17 (Figure 13).

The details of the construction can be modified without departing from the scope of the invention, within the range of technical equivalences.

### Claims

1. Grinding device comprising a grinding wheel which turns at high speed and whose working surface comprises notches, characterized in that the dimensions and the arrangement of the notches, which are in the shape of slits, holes, etc. provided in the grinding wheel, are such that the worker while working can see, opposite his/her eyes and through said notches, the piece which is brought in contact with the face of the grinding wheel, that is to say the point of attack of the grinding wheel.

2. Embodiments of the grinding device according to Claim 1, characterized by the following characteristics:

a. The lateral surfaces of at least a part of the notches that are in the shape of slits, or the axes of at least a part of the notches that are in the shape of holes, are inclined with reference to the faces of the grinding wheel, if the latter is flat, or with respect to its generating line if it is in the shape of a cup, respectively;

b. A disk which turns with a grinding wheel is arranged against the face of the grinding wheel that is oriented toward the worker, wherein this disk has notches identical to those of the grinding wheel, the connector bars which separate the notches being curved in the shape of helicoidal blades;

c. The notches are replaced by rows of holes arranged in spiral patterns starting from the center of the grinding wheel, where the axis of each hole is located on the cylinder which is concentric with respect to the grinding wheel and tangential to the adjacent holes, and where the grinding wheel is preferably inserted in a support perforated in an identical manner;

d. The piece can be illuminated by a light beam which is directed through the notches of the grinding wheel toward the surface that is in the process of being ground, and reflected by the surface toward the worker.

e. At least the part of the body of the grinding wheel which extends between the notches and which is directed toward the worker is tinted in matte black;

f. A light source is provided at a small distance from the face of the grinding wheel, in proximity to the shaft of the grinding wheel, wherein this light source is masked by a screen in the slit area that extends to the immediate vicinity of the face of the grinding wheel;

g. The screen forms a frustrum-truncated cone which surrounds the shaft of the grinding wheel, the edge forming the base of the cone engages in a recess of the face of the grinding wheel or behind the bent edge of a disk applied against the face of the grinding wheel, this disk being provided with slits in an identical manner and rotating with the grinding wheel;

h. The terminal faces of the notches in the shape of slits in the grinding wheel obliquely cut the axis of the grinding wheel;

i. The grinding wheel is mounted so it can pivot about a horizontal axis which is parallel to its faces, and so it can be immobilized in the desired position;

j. An electrical motor is mounted so it can pivot about a horizontal axis intersecting its shaft in its middle, and capable of being immobilized in the desired position, and the grinding wheel is mounted in cantilever fashion on each side, on the extensions of the shaft of the motor.

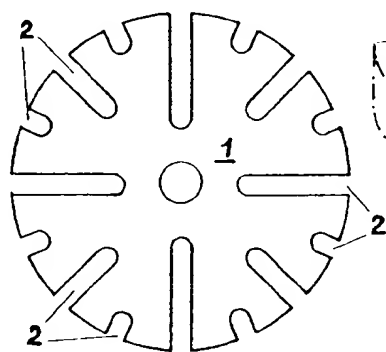


Fig. 1

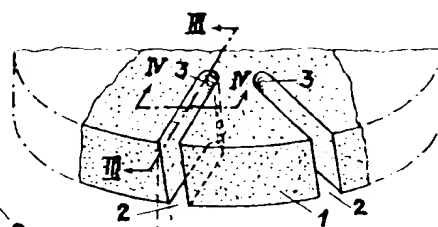


Fig. 2



Fig. 3

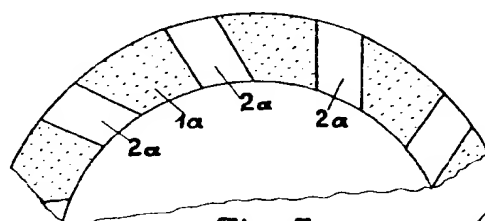


Fig. 5



Fig. 4

Fig. 7

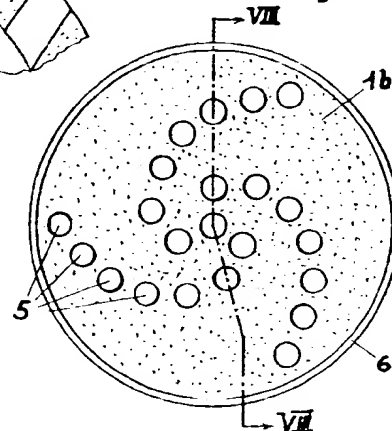


Fig. 8

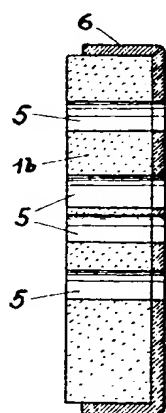
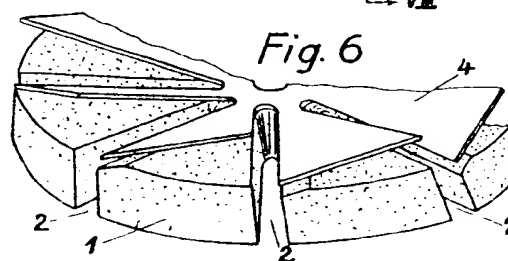
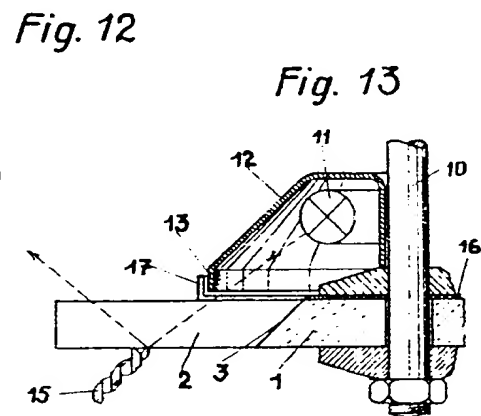
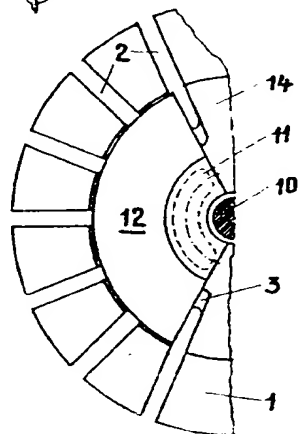
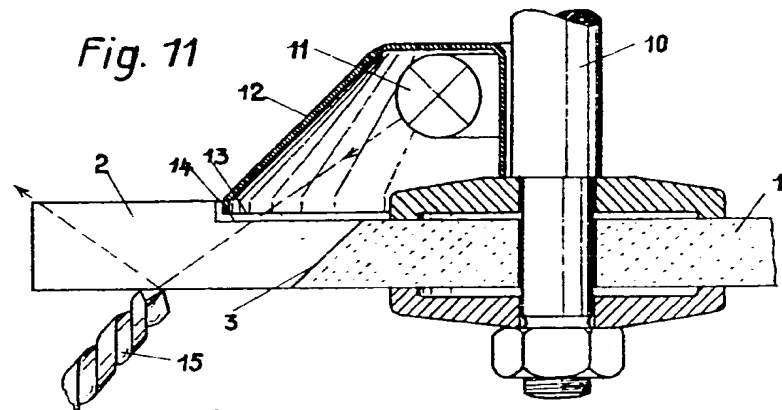
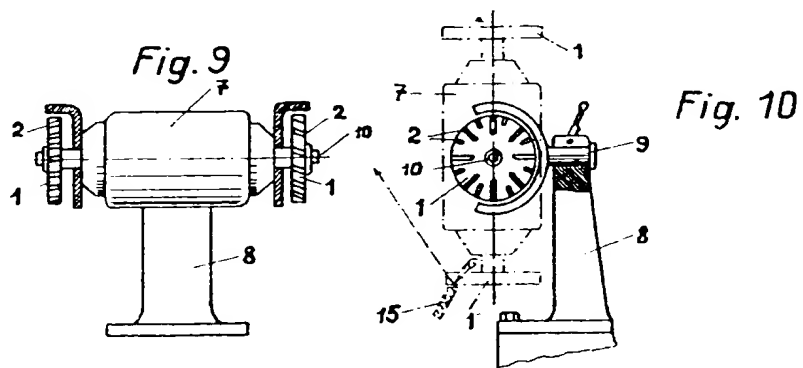


Fig. 6





# BREVET D'INVENTION

Gr. 5. — Cl. 4.

N° 1.075.634

Dispositif de meulage à meule entaillée permettant d'observer le travail effectué.

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Les méthodes et les dispositifs de meulage connus jusqu'à présent ne permettent pas de surveiller la surface en cours de meulage pendant que s'effectue l'opération. Il faut donc écarter de temps en temps de la meule la pièce à meuler pour la refroidir ou pour la contrôler et il en résulte des attaques répétées des surfaces usinées, de sorte que ces surfaces manquent de précision et de fini.

La présente invention concerne un dispositif de meulage comportant une meule tournant à grande vitesse dont la surface de travail présente des entailles grâce auxquelles il est possible de remédier à ces inconvénients. La dimension et la disposition de ces entailles prévues dans la meule sous forme de fentes, de trous, etc. sont en effet telles que l'ouvrier puisse voir pendant le travail la pièce amenée en contact avec la face de la meule opposée à son regard, c'est-à-dire avec la face d'attaque de cette meule, à travers les entailles pratiquées dans la meule. On sait qu'un objet placé derrière un disque pourvu d'entailles et animé d'un mouvement de rotation devient parfaitement visible à partir d'une certaine vitesse de rotation. Grâce au dispositif, objet de la présente invention, il est donc possible de surveiller la surface meulée pendant l'opération, notamment pour déterminer par exemple le moment précis où le meulage doit être interrompu ou pour déterminer l'angle exact selon lequel le meulage doit être effectué. En outre, il est également possible de replacer la pièce dans sa position initiale par rapport à la meule après l'en avoir écartée (par exemple pour la refroidir). Il existe bien des meules dont les surfaces de travail présentent des entailles, mais ces entailles sont soit trop étroites, soit trop larges, de sorte que le phénomène stroboscopique ne se produit pas. D'ailleurs ces entailles ménagées sur la périphérie de la meule n'ont pas le même but.

La présente invention apporte un autre perfectionnement aux dispositifs de meulage connus. Selon ce perfectionnement, on incline les surfaces latérales d'au moins une partie des entailles, lorsqu'elles sont en forme de fentes, ou les axes d'au

moins une partie de ces entailles lorsqu'elles sont en forme de trous, par rapport aux surfaces des meules en forme de disque ou à la génératrice des meules en forme de cuvette. Les flancs des fentes, ou les axes des trous, ne sont donc plus orientés normalement à la surface périphérique ou de travail de la meule considérée, mais sont inclinés. La meule agit donc en quelque sorte comme une hélice, provoque un fort courant ou remous d'air et assure automatiquement le refroidissement, de sorte que, dans bien des cas, il est possible de se passer d'un dispositif spécial de refroidissement par eau.

Suivant une autre particularité de l'invention, il est également possible d'obtenir ou de renforcer cet effet en disposant sur la face de la meule orientée du côté de l'ouvrier un disque tournant avec la meule, fendu de la même façon, et dont les pontets séparant les fentes sont recourbés en forme de pales d'hélice. En tournant, ce disque agit comme une hélice et provoque un courant d'air plus intense à travers les fentes ou les trous de la meule, ce courant d'air se déplaçant rationnellement de l'ouvrier vers la pièce, ce qui empêche la détérioration éventuelle des arêtes par brûlure (ou coup de feu) sans qu'il soit besoin de prévoir un autre mode de refroidissement. Il va de soi que, dans les deux cas, la dimension des fentes ou des trous ou bien l'inclinaison des parois latérales des fentes (ou les axes des trous) doit être telle qu'il soit encore possible de voir au travers.

Suivant la présente invention, ces entailles peuvent être également prévues sous forme de rangées de trous disposées en spirales à partir du centre de la meule, l'axe de chaque trou étant situé sur le cylindre concentrique à la meule et tangentiel aux trous voisins, et la meule étant de préférence encastrée dans un support troué de façon identique. On parvient ainsi à ce résultat que la meule est uniformément « transparente » en tous ses points et qu'un chevauchement pouvant éventuellement se produire avec des fentes radiales pour une vitesse de rotation trop faible est absolument évité. Mais étant donné que ces rangées

plan et en coupe transversale d'une meule comportant des rangées de trous disposés en spirales;

Les fig. 9 et 10 sont respectivement des vues de face et de côté d'un dispositif de meulage;

Les fig. 11 et 12 sont respectivement des vues en coupe et en plan d'un dispositif d'éclairage;

La fig. 13 montre un autre mode de réalisation du dispositif d'éclairage également en coupe.

La meule plate 1 que montre la fig. 1 présente des fentes radiales 2 qui, lorsque la meule tourne, permettent au regard d'accéder à la pièce qui se trouve derrière cette meule. Pour obtenir une vue « par transparence » régulière, les fentes 2 sont de longueurs différentes de façon qu'il y ait à la périphérie de chaque cercle concentrique à peu près la même proportion de surface entaillée et de surface de travail. Comme on peut le voir sur les fig. 2 et 4, les parois latérales des entailles 2 en forme de fentes de la meule plate 1 peuvent être inclinées par rapport aux faces de la meule. De même, il est possible que les faces terminales 3 des entailles 2 en forme de fentes soient orientées obliquement, c'est-à-dire qu'elles coupent obliquement l'axe de la meule ou qu'elles décrivent en tournant un cône autour de l'axe de la meule. Les parois latérales des fentes 2a de la meule en forme de cuvette que montre la fig. 5 sont de même orientées obliquement par rapport à la génératrice de la meule.

Le disque 4 que montre la fig. 6 est disposé contre la face de la meule 1 et tourne avec elle. Ce disque est également entaillé et les pontets s'étendant entre ces entailles sont recourbés en forme de pales d'hélice, ce qui, lors de la rotation, engendre un violent courant d'air à travers les fentes de la meule et rend superflu tout refroidissement supplémentaire pendant le meulage.

La meule plate 1b que montrent les fig. 7 et 8 présente trois rangées de trous 5 disposés en spirale. L'axe de chaque trou est situé sur le cylindre concentrique à la meule et tangentiel aux deux trous voisins. La meule 1b est elle-même encastree dans un support 6 présentant des trous semblables.

Comme le montrent les fig. 9 et 10, un mode de réalisation possible du dispositif de meulage conforme à l'invention comporte un moteur électrique 7 porté par un axe 9 monté à pivotement sur un bâti 8 et pouvant être immobilisé dans la position choisie. Sur l'arbre 10 du moteur électrique, prolongé de chaque côté de celui-ci, sont montées en porte-à-faux deux meules plates 1. Sur la fig. 10, la position des meules et du moteur en vue de l'opération de dressage est indiquée en traits mixtes, ainsi que le mode d'éclairage le plus rationnel pour cette opération.

Comme on peut le voir sur les fig. 11 et 12, il est prévu, à courte distance de la face de la meule 1 et à proximité de l'arbre 10 de la meule,

un corps lumineux 11 en forme de tube masqué vers l'extérieur par un écran 12. Cet écran 12 constitue une partie d'un cône entourant l'arbre de la meule et le bord 13 formant la base de ce cône s'engage dans une dépression 14 de la face de la meule. On voit nettement sur la fig. 11 que grâce à ce mode particulier de protection aucune lumière ne peut plus parvenir sur le bord extérieur de la meule et que les rayons lumineux ne sont réfléchis que par la surface meulée de la pièce 15, en direction des yeux de l'ouvrier. A la place de la dépression 14 prévue sur la face de la meule, il peut également être prévu un disque 16 appliqué contre la face de la meule, entaillé de même et tournant avec elle, et dont le bord 17 est recourbé. Le bord 13 formant la base de l'écran 12 s'engage également derrière le bord recourbé 17 (fig. 13).

Les détails de construction peuvent être modifiés, sans s'écarter de l'invention, dans le domaine des équivalences techniques.

#### RÉSUMÉ

1° Dispositif de meulage comportant une meule tournant à grande vitesse et dont la surface de travail comporte des entailles, caractérisé en ce que les dimensions et la disposition des entailles en forme de fentes, de trous, etc. prévues dans la meule sont telles que l'ouvrier puisse, pendant le travail, voir la pièce amenée au contact de la face de la meule opposée à son regard, c'est-à-dire le point d'attaque de la meule, à travers lesdites entailles.

2° Modes de réalisation du dispositif de meulage suivant 1°, caractérisé par les particularités suivantes :

a. Les surfaces latérales d'au moins une partie des entailles en forme de fentes ou les axes d'au moins une partie des entailles en forme de trous sont inclinés par rapport aux faces de la meule, lorsqu'elle est plate, ou respectivement par rapport à sa génératrice lorsqu'elle est en forme de cuvette;

b. Un disque tournant avec la meule est disposé contre la face de la meule orientée du côté de l'ouvrier, ce disque présentant des entailles identiques à celles de la meule, les pontets séparant les entailles étant recourbés en forme de pales d'hélice;

c. Les entailles sont remplacées par des rangées de trous disposés en spirales en partant du centre de la meule, l'axe de chaque trou étant situé sur le cylindre concentrique à la meule et tangentiel aux trous voisins, la meule étant de préférence encastree dans un support troué de façon identique;

d. La pièce peut être éclairée par un faisceau lumineux dirigé sur la surface en cours de meulage à travers les entailles de la meule et réfléchi par cette surface en direction de l'ouvrier;

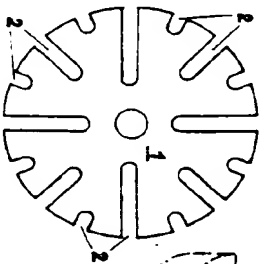


Fig. 1

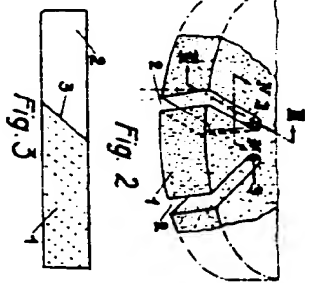


Fig. 2



Fig. 3

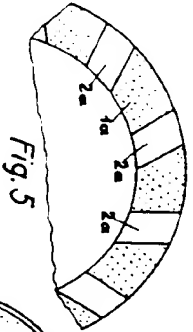


Fig. 4

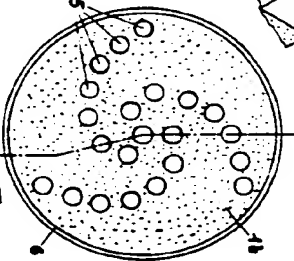


Fig. 5

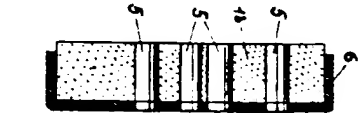


Fig. 6

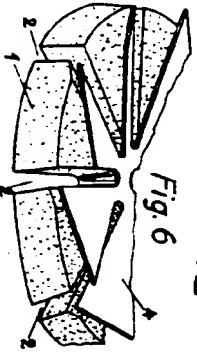


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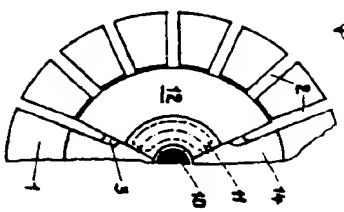


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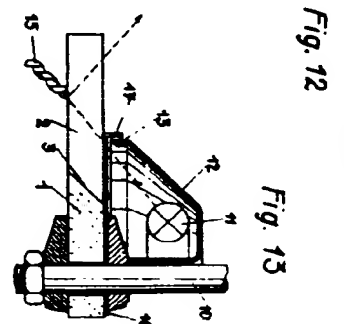


Fig. 9

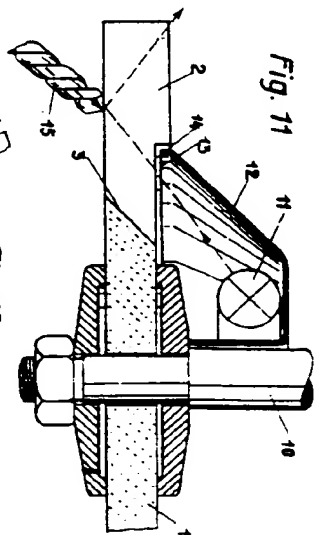


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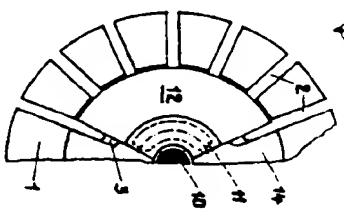


Fig. 11

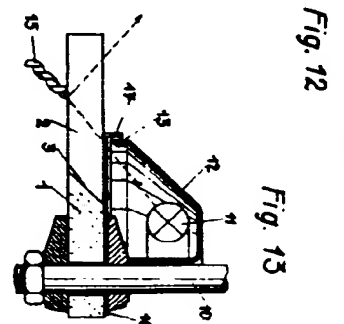


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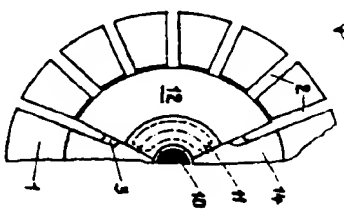


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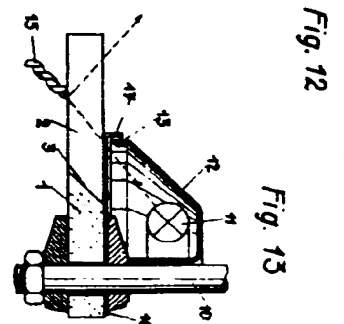


Fig. 14

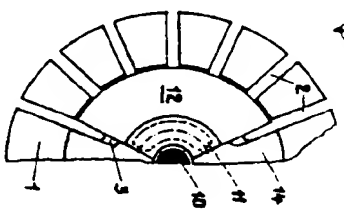


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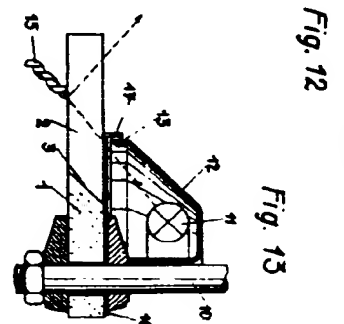


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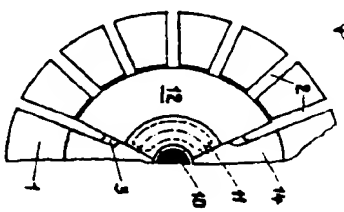


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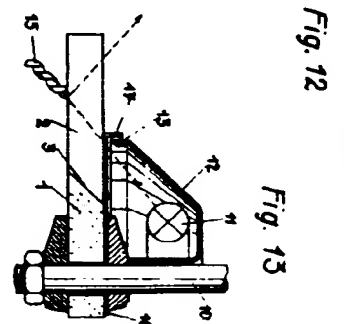


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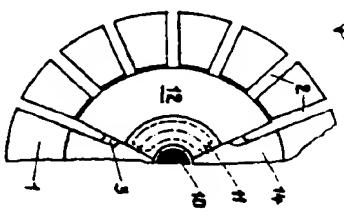


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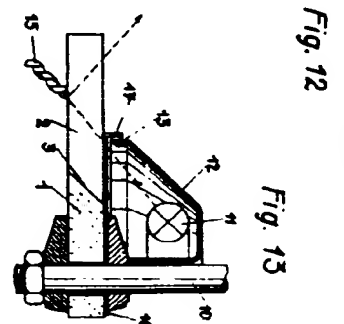


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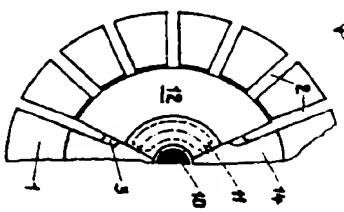


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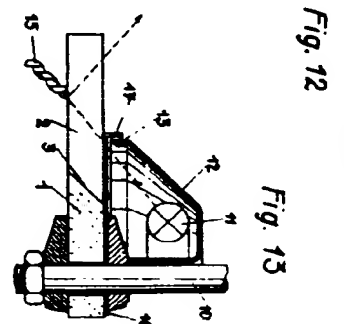


Fig. 22

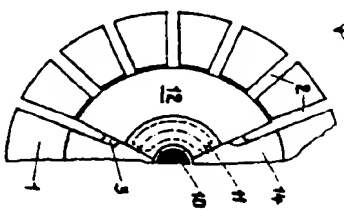


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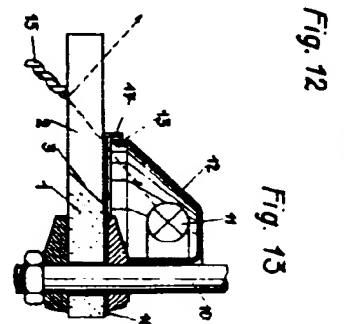


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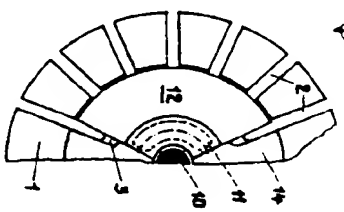


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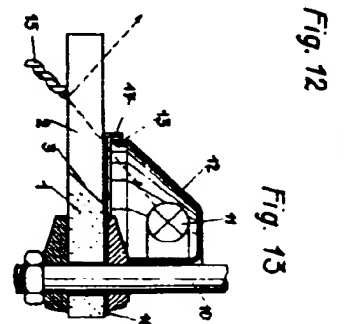


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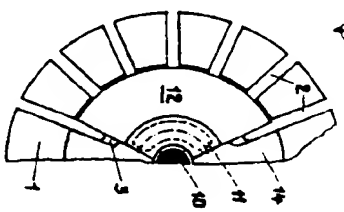


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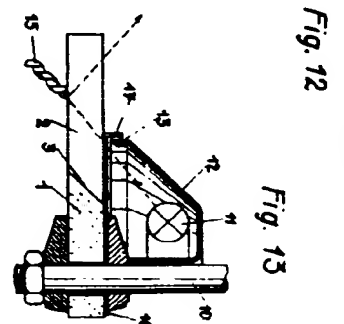


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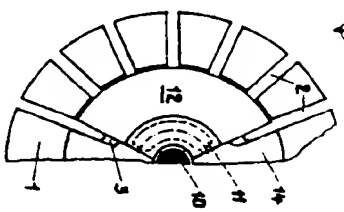


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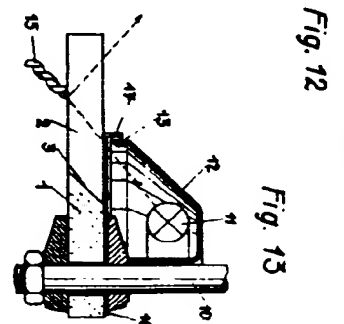


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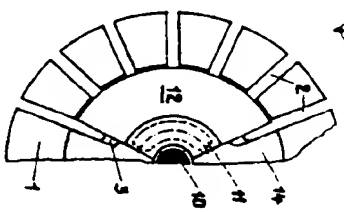


Fig. 31

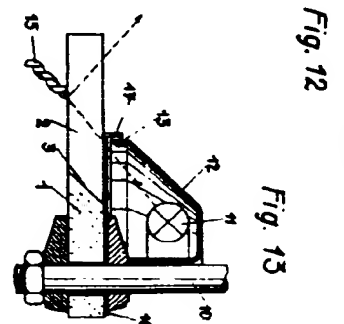


Fig. 32

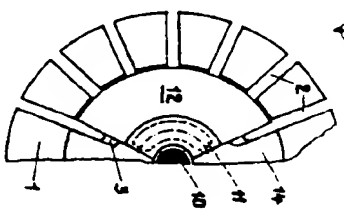


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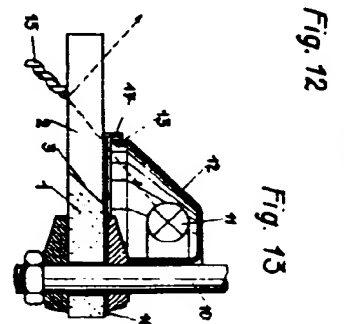


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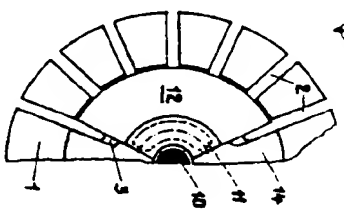


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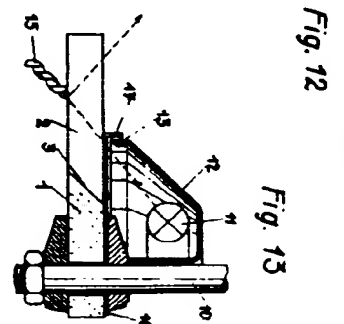


Fig. 36

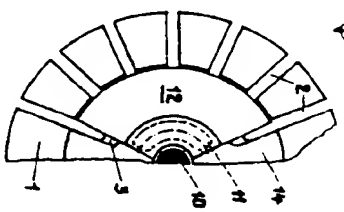


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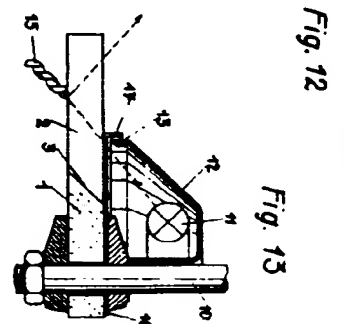


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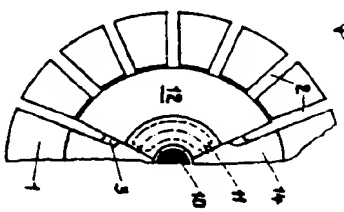


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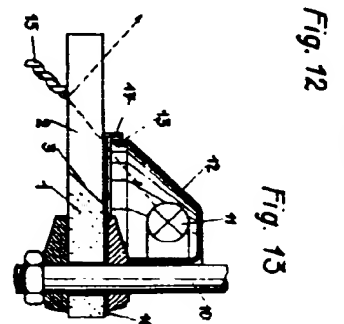


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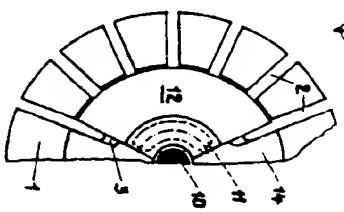


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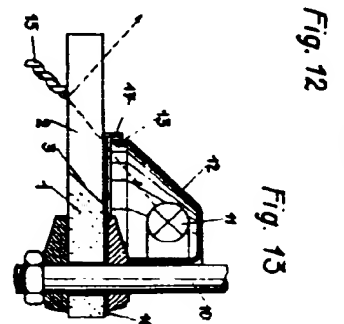


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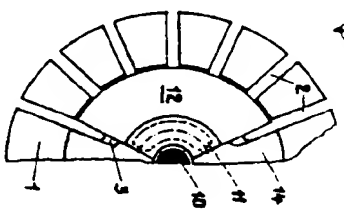


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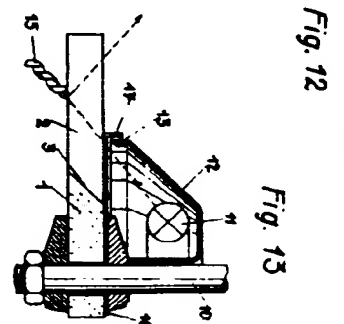


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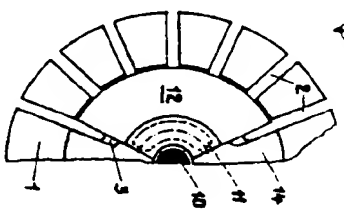


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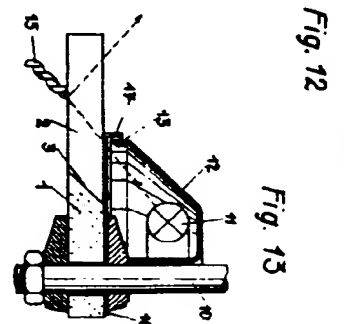


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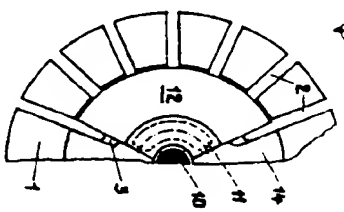


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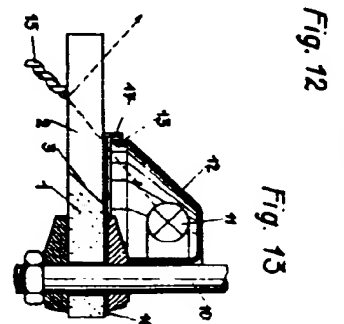


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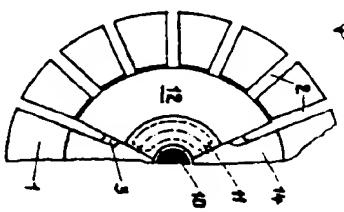


Fig. 49

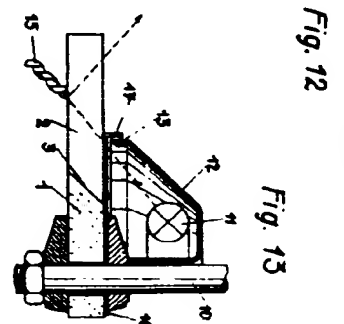


Fig. 50

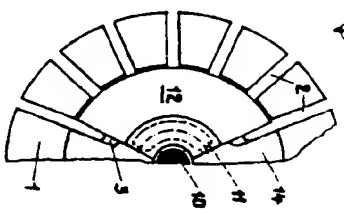


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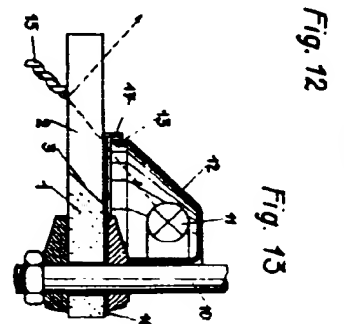


Fig. 52

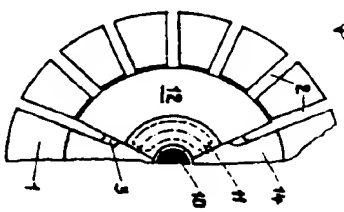


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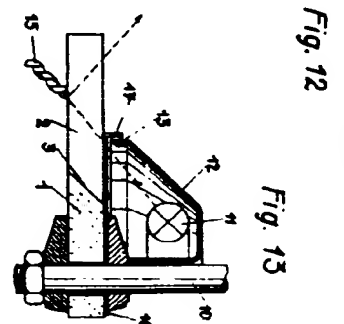


Fig. 54

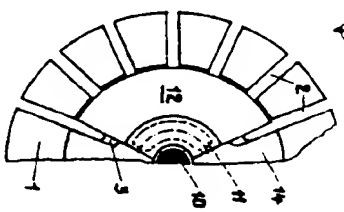


Fig. 55

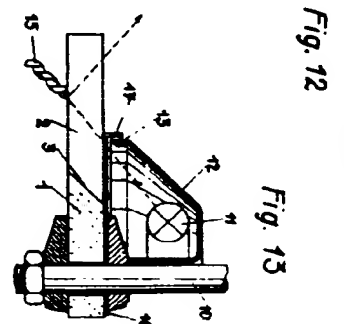


Fig. 56

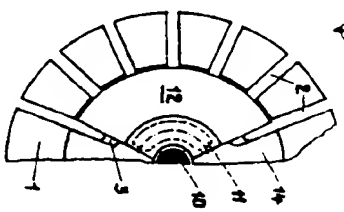


Fig. 57

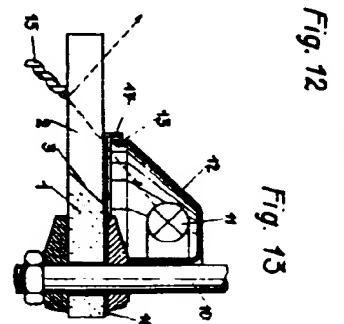


Fig. 58

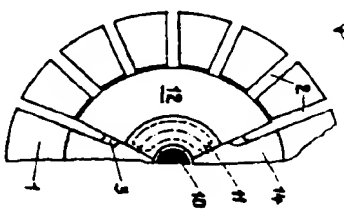


Fig. 59

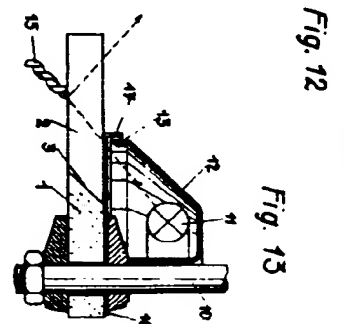


Fig. 60

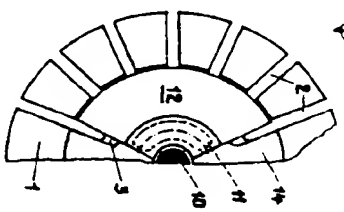


Fig. 61

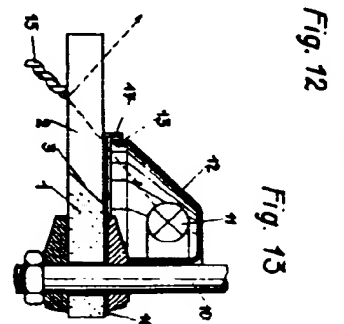


Fig. 62

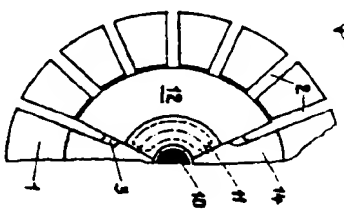


Fig. 63

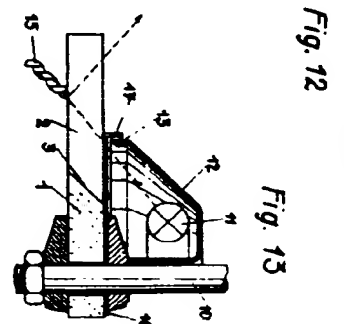


Fig. 64

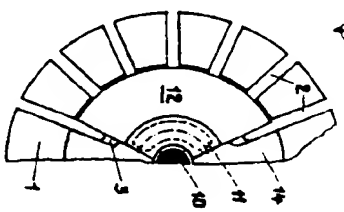


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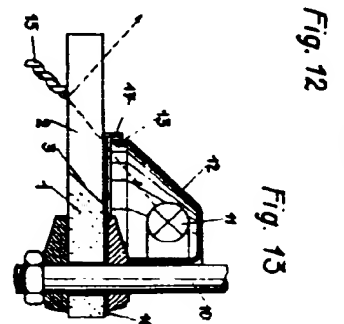


Fig. 66

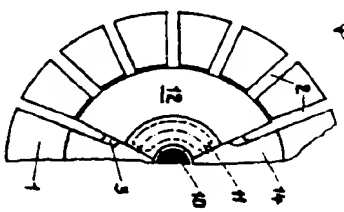


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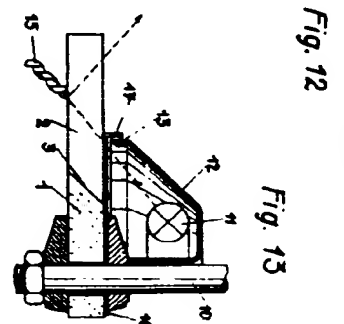


Fig. 68

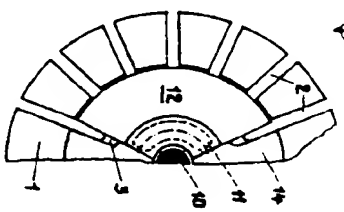


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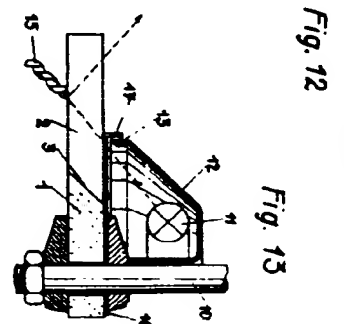


Fig. 70

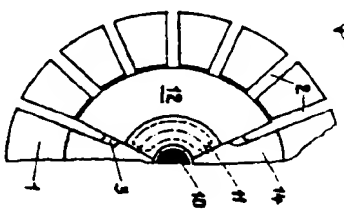


Fig. 71

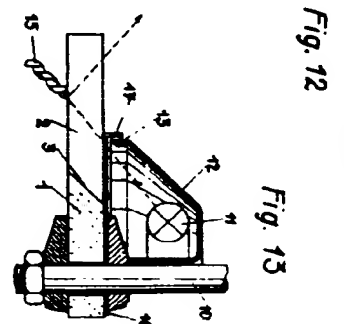


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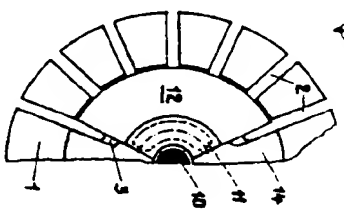


Fig. 73

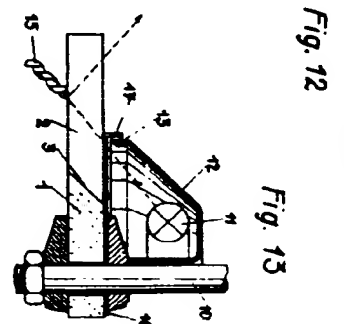


Fig. 74

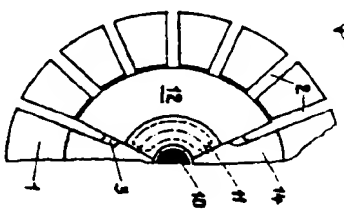


Fig. 75

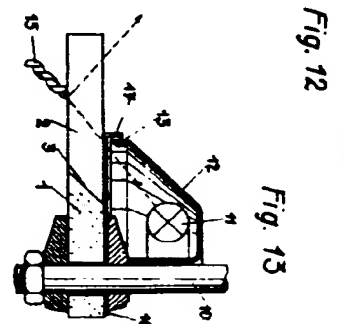


Fig. 76

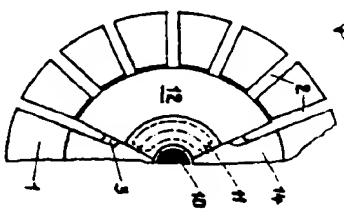


Fig. 77

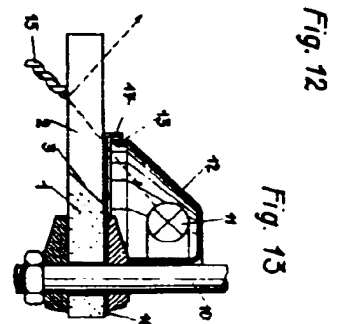


Fig. 78

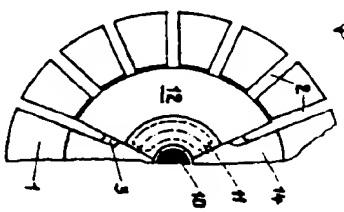


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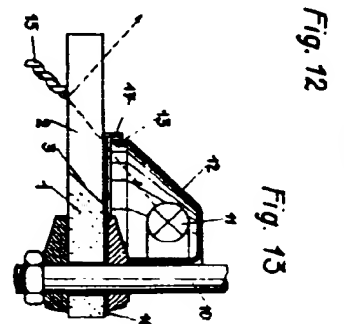


Fig. 80

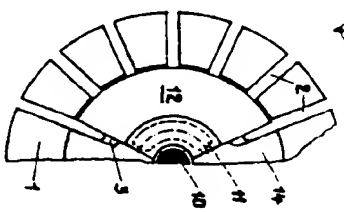


Fig. 81

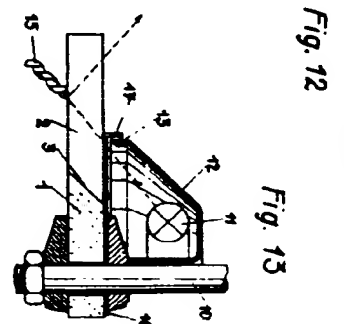


Fig. 82

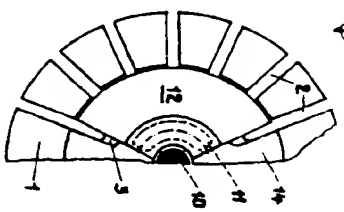


Fig. 83

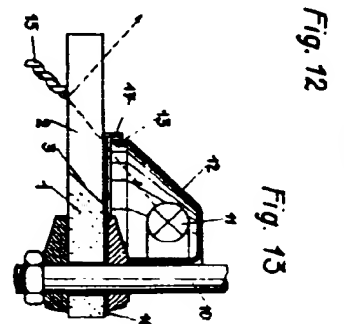


Fig. 84

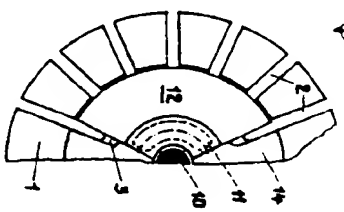


Fig. 85

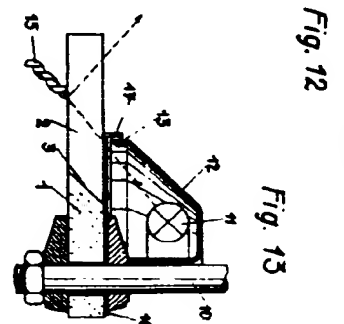


Fig. 86

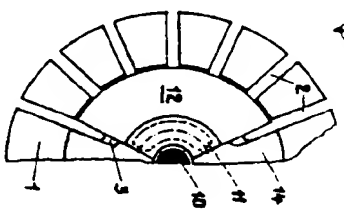


Fig. 87

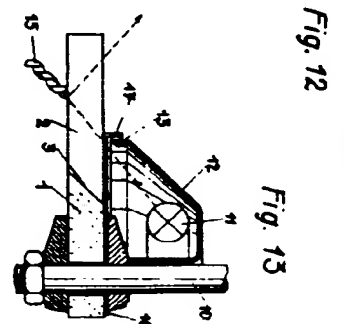


Fig. 88

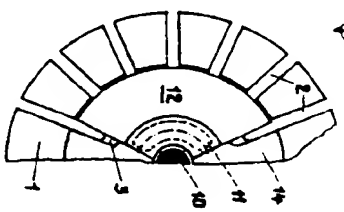


Fig. 89

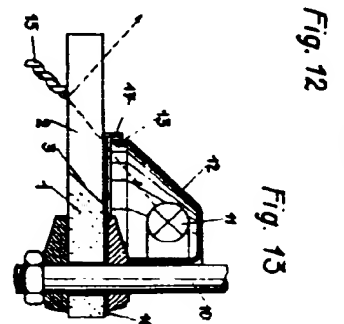


Fig. 90

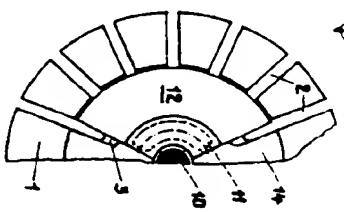


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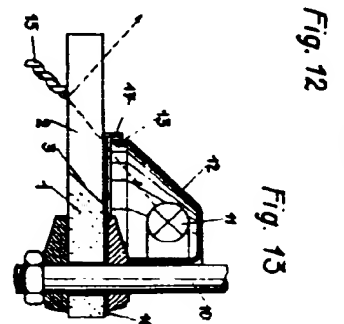


Fig. 92

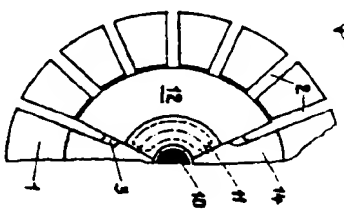


Fig. 93

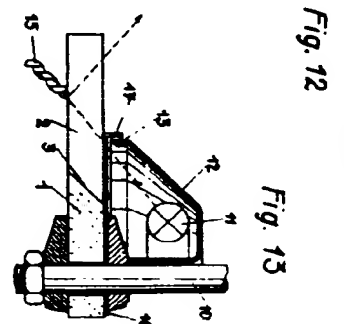


Fig. 94

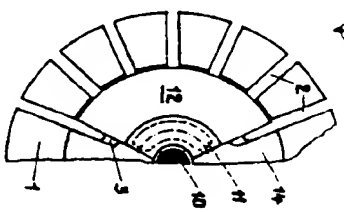


Fig. 95

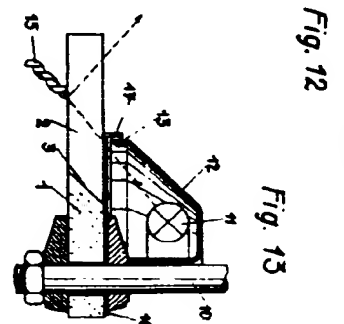


Fig. 96

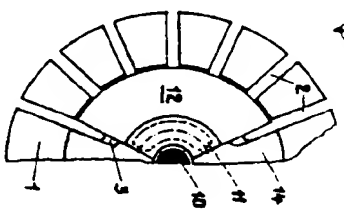


Fig. 97

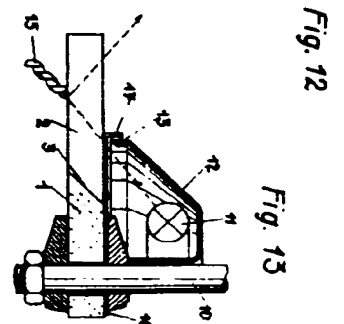


Fig. 98

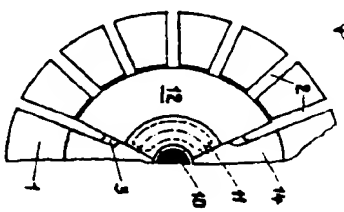


Fig. 99

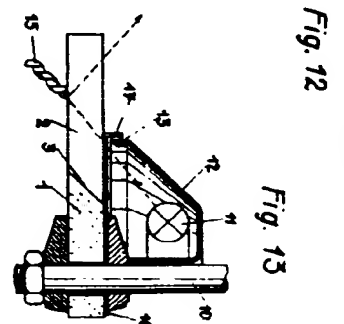


Fig. 100

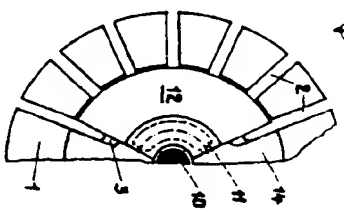


Fig. 101

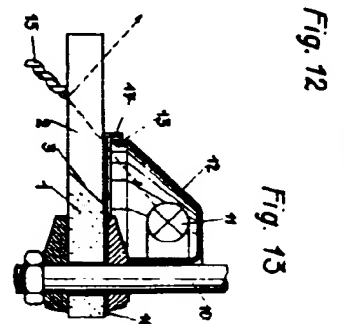


Fig. 102

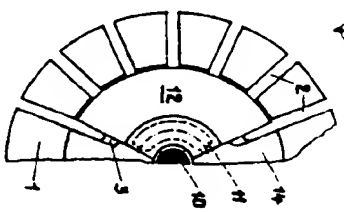


Fig. 103

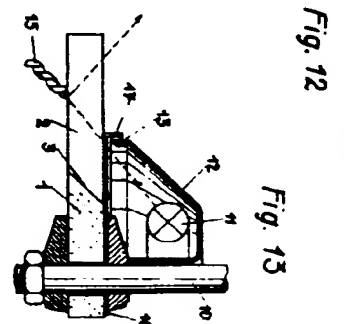


Fig. 104

